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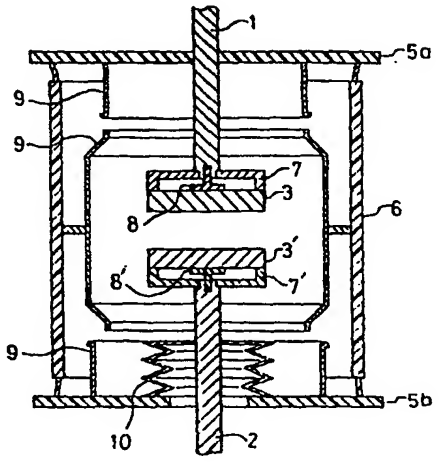
(54) **Electrode of vacuum circuit breaker.**

(57) An electrode for using in the vacuum circuit breaker, has at least one gap part, for generating the magnetic field in axial direction of its moving action. In an electrode of vacuum circuit breaker in accordance with the present invention, the electrode is constituted by a main electrode having at least one gap for generating the magnetic field in axial direction of its moving action, a sub-electrode having the same shape and disposed the back face of the main electrode. And the electric conductivity of the material of the sub-electrode is higher than that of the main electrode, for generating the magnetic field effectively in the axial direction.

FIG.1



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TITLE OF THE INVENTION

Electrode of vacuum circuit breaker

BACKGROUND OF THE IVNENTION

1. FIELD OF THE INVENTION:

The present invention relates to electrodes of a vacuum circuit breaker, and especially to the electrode construction having sub-electrode on the back face of main electrode.

2. DESCRIPTION OF THE RELATED ART

In FIG.1, which is a sectional side view of a typical example of a general vacuum circuit breaker,the vacuum circuit breaker comprises, an upper and a lower electrodes 3 and 3' facing to each other, a pair of conductor rods 1 and 2, a vacuum tube 6 to define a chamber, a fixed base 5a, a moving base 5b, shield members 9 and a bellows 10. The upper electrode 3 is fixed on the fixed base 5a via the conductor rod 1 connected inbetween, and the lower electrode 3' is mounted on the moving base 5b via the conductor rod 2 and the bellows 10.

FIG.2 is a perspective vies of a conventional electrode of vacuum circuit breaker, which is shown, for example, in the Japanese publised patent unexamined application Sho 58-100325. In FIG.2, the top part of the conductor rod 1 has a cylinder part 1a, which fits into a center hole 7e of a connection ring 7a of a

connection member 7. The connection member 7 has four arms 7b extended in radial directions, and the tip part of the arms 7b have respectively contact parts 7c in vertically upper direction of the arms 7b. The main electrode 3 is fixed on the connection member 7, which has a disk part 3a, and four coil parts 3b all extending in the same tangential direction along and outside the circumference. And foundation parts 3c of the coil parts 3b are formed continuously from the disk part 3a. The back faces 3d of the end tip parts of the coil parts 3b and the corresponding front faces 7d of the contact parts 7c of the connection member 7 are respectively connected with each other. Thereby, the main electrode 3 and the conductor rod 1 are electrically connected with each other. Further, the stick part 8a of the fixing member 8 is fitted into the hole 1c of the cylinder part 1a of the conductor rod 1, and the cylinder part 1a is fitted in the hole 7e at the face of the center part of the connection member 7. And a pair of conductor rods 1, the connection members 7, the main electrodes 3 and the fixing members 8 are disposed against each other in a vacuum tube 6, which is shown in FIG.1.

In FIG.2 and FIG.3, in case that an arc spot is generated by pulling apart of electrodes at the center part of the main electrode 3 which is designated

by P, an electric currents flow from the center point P in radial direction along the path designated by R, and further electric currents flow through the base parts 3c, the coil parts 3b, the back parts 3d of the coil parts 3b, the contact parts 7c of the connection member 7, the arms 7b, and the connection ring 7a and to the conductor rod 1. Therefore, a magnetic field is formed in the axial direction of the main electrode 3. In this device, there is another electric path from the main electrode 3 to the conductor rod 1 through the fixing member 8. Since the latter electric path undesirably works to decrease the axial magnetic field, such a high electrical resistance material as to limit the electric current in the latter path is used for the fixing member 8, thereby intending effectively to form the magnetic field of the axial direction.

Generally, the vacuum circuit breaker has such constitution as mentioned above, for making the magnetic field in the axial direction in order to effectively blow out the arc to avoid melting down of the electrode. However, since a material of the main electrode 3 generally has a high resistance, the electric current from the main electrode 3 to the conductor rod 1 does not flow through the path of the current formed of the disk part 3a of the main electrode 3, through the base part 3c, the coil part

3b, the back part 3d, the contact part 7c of the connection member 7, the arm 7b, the connection ring 7a and to the conductor rod 1, but actual current flows through a path from the main electrode 3, through the fixing member 8 and to the conductor rod 1, (this is because the disk part 3a, the coil part 3b, the base part 3c and the back part 3d which are parts of the main electrode 3 have a low conductivity. Thus, the magnetic field in axial direction is not formed effectively.

SUMMARY OF THE INVENTION

Accordingly, the purpose of the present invention is to provide an improved electrode of vacuum circuit breaker, having the conventional coil action part on its circumference and further having a sub-electrode part which is made of higher conductivity materials than the material of the main electrode, thereby to enable satisfactory function of arc extinguishing.

An electrode of vacuum circuit breaker in accordance with the present invention comprises;

a conductor rod to be connected to an electric power line,

a main electrode of an electric contact metal which has a center disk part at its center part, plural number of arm parts provided at its peripheral part and

extending in the same circumfer nce direction with gap parts therebetween,

a sub-electrode of a metal f higher conductivity than the electric contact metal having the same shape as and bonded on the back face of the main electrode, and

a connection member which is of an electrically conductive metal, has a center part to be connected to the conductor rod and plural arm parts connected by their ends to the ends of the arm parts.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG.1 is the cross-sectional view of the vacuum circuit breaker in general, wherein the conventional electrode as well as an electrode in accordance with the present invention is used.

FIG.2 is the perspective view of the constitution of the conventional electrode of the vacuum circuit breaker.

FIG.3 is the plan view of the conventional electrode of the vacuum circuit breaker.

FIG.4 is a perspective view of a preferred embodiment of the constitution of an electrode of vacuum circuit breaker in accordance with the present invention.

FIG.5 is a perspective view of an electrode of FIG.1, which shows an arc spot P and an electric

current.

FIG.6(a) and FIG.6(b) are cross-sectional views of two modes of main electrode 103 and sub-electrode 104 of FIG.5.

FIG.7(a) is a side view of another embodiment of electrodes of vacuum circuit breaker in accordance with the present invention.

FIG.7(b) and FIG.7(c) are bottom view and plan view of the electrode of FIG.7(a),respectively.

FIG.8(a) is a side view of still other embodiment of electrodes of vacuum circuit breaker in accordance with the present invention.

FIG.8(b) and FIG.8(c) are bottom view and plan viewgs of electrode of FIG.8(a),respectively.

FIG.9(a) is a side view of still other embodiment of electrodes of vacuum circuit breaker in accordance with the present invention.

FIG.9(b) and FIG.9(c) are bottom view and plan view of electrodes of FIG.9(a),respectively.

FIG.10 is a plan view of still other embodiment of an electrode used in the vacuum circuit breaker of FIG.9(a),

FIG.11 is a plan view or bottom view of still other embodiment of electrodes used in the vacuum circuit breaker of FIG.9(a).

FIG.12 is a plan view or bottom view of still

other embodiment of electrodes used in the vacuum circuit breaker of FIG.9(a).

FIG.13(a) is a side view of still other embodiment of electrodes of vacuum circuit breaker in accordance with the present invention.

FIG.13(b) and FIG.13(c) are bottom view and plan view of electrodes of FIG.13(a),respectively.

FIG.14(a) and FIG.14(b) are bottom view and plan view of still other embodiment of electrodes used in the vacuum circuit breaker of FIG.13(a),respectively.

FIG.15(a) and FIG.15(b) are bottom view and plan view of still other embodiment of electrodes used in the vacuum circuit breaker of FIG.13(a),respectively.

FIG.16(a) is a cross-sectional side view of still other embodiment of electrodes of vacuum circuit breaker in accordance with the present invention.

FIG.16(b) and FIG.16(c) are bottom view and plan view of electrodes of FIG.16(a),respectively.

FIG.17(a) is a cross-sectional side view of still other embodiment of electrodes of vacuum circuit breaker in accordance with the present invention.

FIG.17(b) and FIG.17(c) are bottom view and plan view of electrodes of FIG.17(a),respectively.

FIG.18(a) is a cross-sectional side view of

still other embodiment of electrodes of vacuum circuit breaker in accordance with the present invention.

FIG.18(b) and FIG.18(c) are bottom view and plan view of electrodes of FIG.18(a),respectively.

FIG.19(a) is a cross-sectional side view of still other embodiment of electrodes of vacuum circuit breaker in accordance with the present invention.

FIG.19(b) and FIG.19(c) are bottom view and plan view of electrodes of FIG.19(a),respectively.

FIG.20(a) is a cross-sectional side view of still other embodiment of an electrode of vacuum circuit breaker in accordance with the present invention.

FIG.20(b) is a plan view of an electrode of FIG.20(a).

FIG.21 is a plan view of still other embodiment of an electrode used in the vacuum circuit breaker of FIG.29.

FIG.22 is a plan view of still other embodiment of an electrode used in the vacuum circuit breaker of FIG.20.

FIG.23 is a plan view of still other embodiment of an electrode of vacuum circuit breaker in accordance with the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

A first preferred embodiment is described

with reference to FIG.4, FIG.5, FIG.6(a) and (b).

In FIG.4, the top part of a conductor rod 101 has a cylinder part 101a, which fits into the center hole 107e of a connection ring 107a of a connection member 107. The connection member 107 also has four arms 107b extended in radial directions, and the tip part of the arms 107b have respectively contact parts 107c in vertically upper direction of the arms 107b. A sub-electrode 104 is fixed on the connection member 107, which has disk part 104a and four coil parts 104b all extending in the same tangential direction along and outside the circumference. And the foundation parts 104c of the coil parts 104b are formed continuously from the disk part 104a. The back faces 104d of the end tip parts of the coil part 104b and the corresponding front faces 107d of the contact parts 107c of the connection member 107 are respectively connected with each other. Further, a main electrode 103, which is made of a known electrode alloy material, and has the same shape as that of the sub-electrode 104, is bonded on the sub-electrode 104 by brazing or the like. So the main electrode 103 and the sub-electrode 104 are electrically and mechanically connected with each other.

A pair of such electrodes are ordinary used as shown in FIG.1 to constitute a switch. In turning-

on of the switch, the bellows 10 is extended and the electrodes 3 and 3' are adhered to each other, and in turning-off of the swich, the electrodes 3 and 3' are pulled apart of each other. At that time, an arc spot is produced between the two electrodes. FIG.5 shows an arc produced in the center point P of main electrode 103. Electric currents I_1 and I_2 are generated by the arc. The electric current I_1 flows from the point P through the center part 103a, the foundation part 103c, the coil part 103b, the back part 103d of coil part 103b, the coil part of sub-electrode 104b, the back part 104b, the contact part 107c of the connection member 107, the arm 107b, the connection ring 107a and to the conductor rod 101, and the electric current I_2 flows from the point P through the center part of sub-electrode 104a, the foundation of sub-electrode 104c, the coil part of sub-electrode 104b, the back part of the coil part of sub-electrode 104d, the contact part 107c of the connection member 107, the arm 107b, the connection ring 107a and to the conductor rod 101.

Hereupon, in case that the main electrode 103 has lower conductivity and the sub-electrode 104 has higher conductivity, detailed explanation is given in following. For example, the material of the main electrode 103 is Cu alloy, Ag alloy or the like, their electric conductivity is about 20 - 50 % of the

conductivity of the pure Cu electrode, and the material of the sub-electrode 104 is Cu, it has about 100 % of the electric conductivity. Assumingly that the conductivity of the material of the main electrode 103 is as high as 20 % of the conductivity of the material of the sub-electrode 104, in other words, the main electrode 103 has a resistance of as high as five times of that of the sub-electrode 104, and the thickness of the main electrode 103 and that of the sub-electrode 104 are equal, then the composite effective resistance of the embodiment is as high as about 33 % of resistance of conventional electrode shown in FIG.2, which is made of the electrode alloy metal and has a thickness equal to the total thickness of the main electrode 103 and the sub-electrode 104. In other words, the total thickness of the main electrode and the sub-electrode 104 in accordance with the present invention can be made thinner than that of the conventional electrode, which can make the same magnitude of electric current for making the arc extinguish magnetic field effectively. In another case that the main electrode 103 has the same conductivity as the sub-electrode 104, the total thickness of the main electrode 103 and the sub-electrode 104 is equal to that of the conventional electrode. The material of the main electrode, however, is generally expensive,

and the material of the sub-electrode is relatively inexpensive. Accordingly, by forming the sub-electrode 104 behind the back face of the main electrode 103, can make the thickness of the main electrode 103 can be made thinner, so that the total cost of the electrode can be reduced. The magnetic field is generated in the axial direction of the conductor rod 101 by the electric currents as shown in FIG.5, so that making of arc in the center part of the electrode designated by P is effective for circuit breaking. FIG.6(a) shows the cross-sectional side view of the electrode having a terraced shape, and FIG.6(b) shows the cross-sectional side view of the electrode having slant periphery shape. These shapes are designed for confining the arc spot in the center part of the electrode.

FIG.7(a), FIG.7(b) and FIG.7(c) show another embodiment in accordance with the present invention. In FIG.7(a), FIG.7(b) and FIG.7(c), conductor rods 151 and 151' respectively have one connection arm 157 and 157'. Furthermore, main electrodes 153 and 153', and sub-electrodes 154 and 154' respectively have a center slit. Holding members 158 and 158' are respectively disposed between the conductor rods 151, 151' and the sub-electrodes 154, 154', and respective holding members 158 and 158' are made of high electric resistance material. Accordingly, the electric

currents does not flow from the conductor rod 151 through the holding member 158 to the sub-electrode 154, but disirably flow as designated by arrow marks. And the magnetic field is generated cirtainly in the axial direction. The arc is generated between P and P'.

FIG.8(a), FIG.8(b) and FIG.8(c) show still other embodiment in accordance with the present invention. This embodiment does not have any connection member, and conductor rod is thicker than the other embodiment shown in FIG.7s. And the contact part of each of the conductor rods 161 and 161' is constituted by a low electric resistance part 165 and 165' and a high electric resistance part 168 and 168'. The high electric resistance part 168 and 168' have a little over three quarters circular region, which are hatched with dotted lines in FIG.8(a),FIG.8(b) and FIG.8(c). The main electrodes 163 and 163', and the sub-electrodes 164 and 164' have respectively cross-shaped slit 163a, 163'a. The electric current flows from the conductor rod 161 through the low electric resistance part 165 and the sub-electrode 164 to the main electrode 163. The magnetic field is generated in the axial direction, and the arc spot is generated between P and P'.

FIG.9(a), FIG.9(b) and FIG.9(c) show still

other embodiment in accordance with the present invention. In such embodiment conductor rods 171 and 171' have one connection arm 177 and 177' of low electric resistance, respectively, and the contact parts 178 and 178' of the conductor rods 171 and 171' are made of high electric resistance material, respectively.

FIG.10, FIG.11 and FIG.12 are plan views of main electrodes which are used in the embodiment of FIG.9s. Of course, the sub-electrodes have respectivrely the same plan views in each case.

FIG.13(a), FIG.13(b) and FIG.13(c) show still other embodiment in accordance with the present invention. In this embodiment, the main electrodes, of course the sub-electrodes have plural slits in parallel. In this case, plural number of arcs are generated as shown in the figures.

FIG.14(a), FIG.14(b), FIG.15(a) and FIG.15(b) are the plan view of main electrodes which are used in the embodiment of FIG.13(a), FIG.13(b) and FIG.13(c).

FIG.16(a), FIG.16(b) and FIG.16(c) show still other embodiment in accordance with the present invention. In this embodiment, the connection arms 197 and 197' face alternately each other.

And FIG.17(a), FIG.17(b) and FIG.17(c) show still other embodiment in accordance with the present

invention. In this embodiment, the connection arms 207 and 207' confront with each other. In such embodiments shown in FIG.13 through FIG.17, the electric currents flow as lines designated by arrow marks, and arcs occur plurally as shown in the figures.

FIG.18(a), FIG.18(b) and FIG.18(c) show still other embodiment in accorcance with the present invention.

FIG.19(a), FIG.19(b) and FIG.19(c) show still other embodiment in accordance with the present invention.

FIG.20(a) and FIG.20(b) show still other embodiment in accordance with the present invention. In this embodiment, a connection member 237 has a pair of opposit arms, and a main electrode 233 has terraced shape.

FIG.21 and FIG.22 are the plan view of the main electrode 233 used in the embodiment shown in FIG.21.

FIG.23 shows still other embodiment in accordance with the present invention. In this embodiment, the connection member 247 has three arms 247a.

What is claimed is:

1. An electrode of vacuum circuit breaker comprising; (in Fig. 4)
a conductor rod to be connected to an electric power line,
a main electrode (103) of an electric contact metal which has a center disk part (103a) at its center part, plural number of arm parts (103b) provided at its peripheral part and extending in the same circumference direction with gap parts therebetween,

a sub-electrode (104) of a metal of higher conductivity than said electric contact metal having the same shape as and bonded on back face of said main electrode (103), and
a connection member (107) which is on an electrically conductive metal, has a center part to be connected to said conductor rod (101) and plural arm parts connected by their ends to said ends of said arm parts.

2. An electrode of vacuum circuit breaker in accordance with claim 1, wherein
conductivity of said sub-electrode is higher than that of said main electrode.

3. An electrode of vacuum circuit breaker in accordance with claim 1, wherein (Fig. 6a)
said main electrode is of terraced shape.

4. An electrode of vacuum circuit breaker in accordance with claim 1, wherein (Fig. 6b)
said main electrode is of slant shape.

5. An electrode of vacuum circuit breaker comprising; (Fig. 7)

a main electrode (153) having at least one gap part,

a sub-electrode (154) having the same shape of said main electrode and being disposed on back face of said main electrode,
a conductor rod connected with an electric power line and having at least one connection part (157) with said sub-electrode, and
a fixing means (158) disposed between said conductor rod (151) and said sub-electrode (154), and having low electric conductivity.

6. An electrode of vacuum circuit breaker in accordance with claim 5, wherein
material of said sub-electrode has higher electric conductivity than that of said main electrode.

7. An electrode of vacuum circuit breaker in accordance with claim 5, wherein
said main electrode is of terraced shape.

8. An electrode of vacuum circuit breaker in accordance with claim 5, wherein
said main electrode is of slant shape.

FIG.1

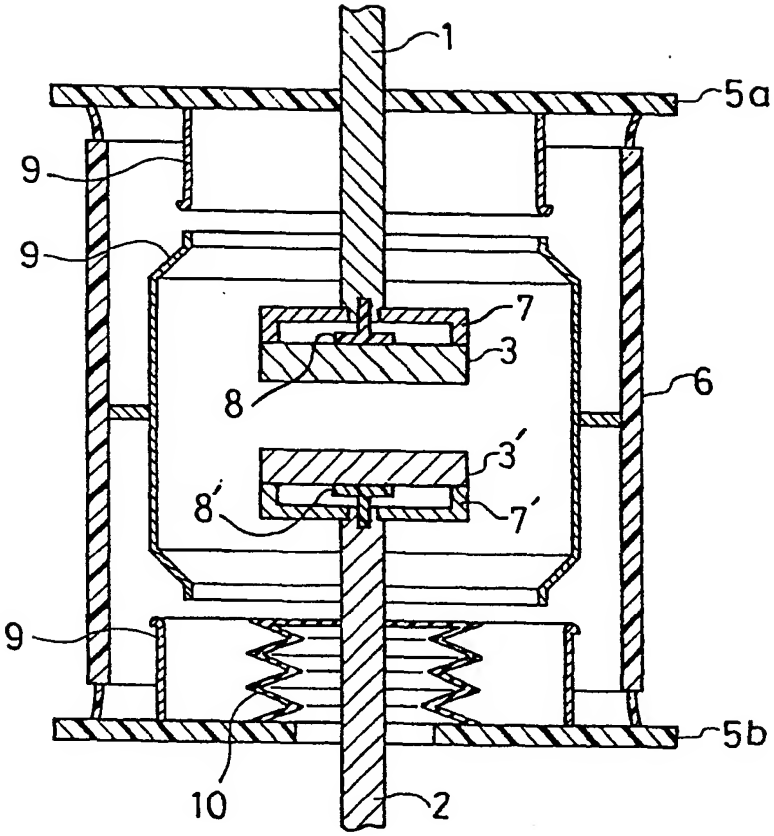


FIG.2 (Prior Art)

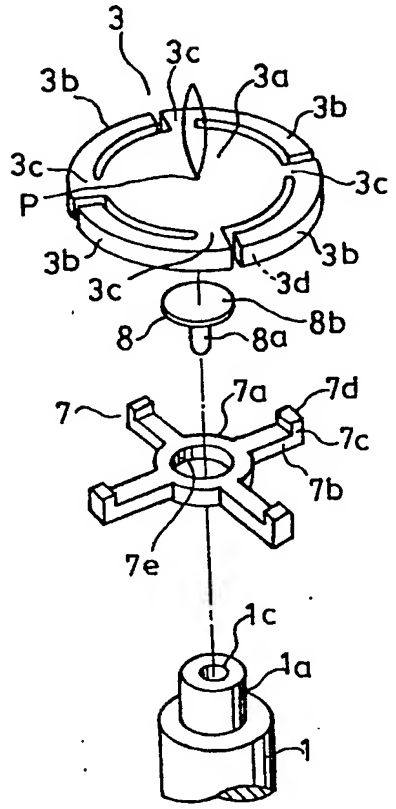


FIG.3 (Prior Art)

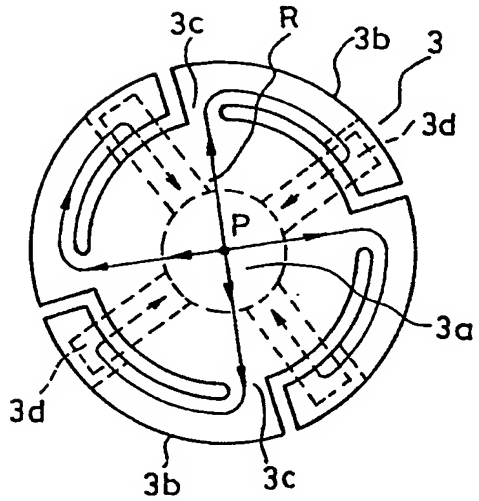


FIG.4

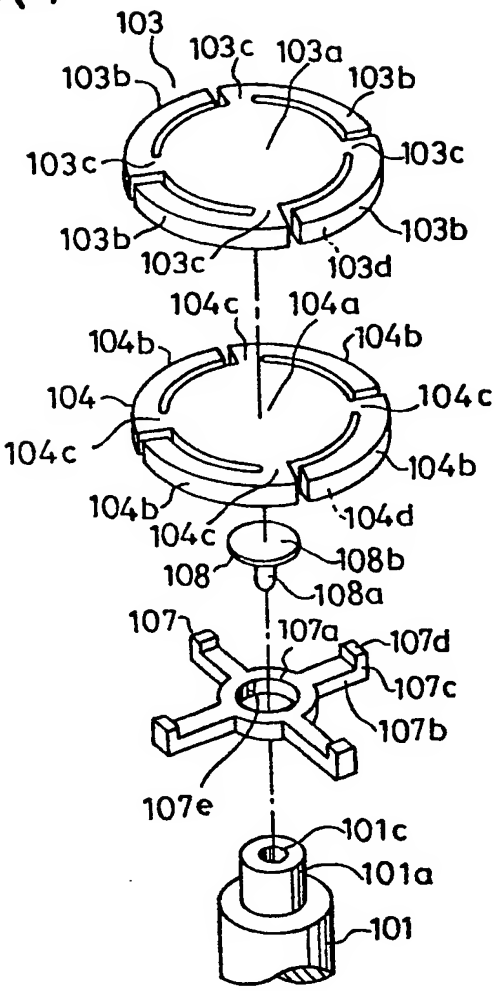

103
103c
103a
103b
103b
103c
103c
103b
103b
103c
103d
104c
104a
104b
104b
104
104c
104c
104b
104b
104c
104d
108b
108
108a
107
107a
107d
107c
107b
107e
101c
101a
101

FIG.5

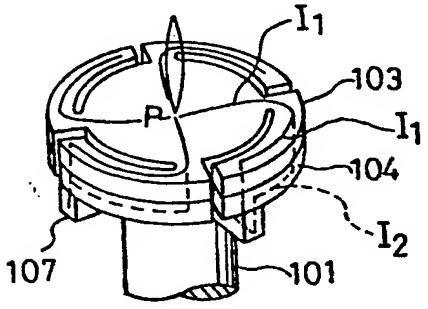

I1
103
P
I1
104
I2
107
101

FIG.6(a)

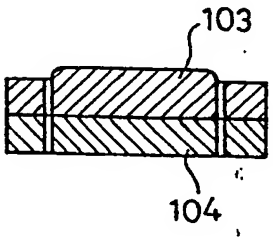


FIG.6(b)

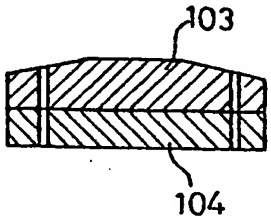


FIG.7(a)

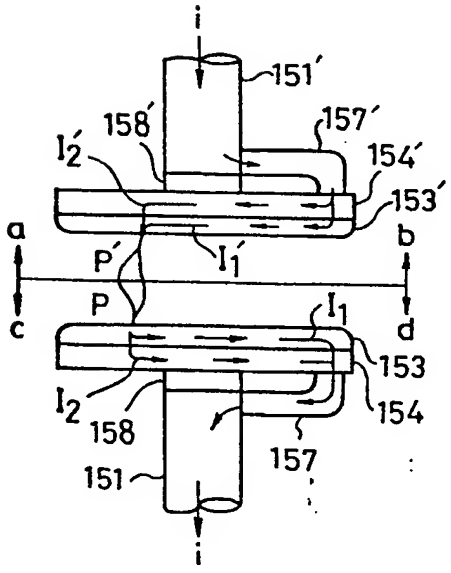


FIG.7(b)

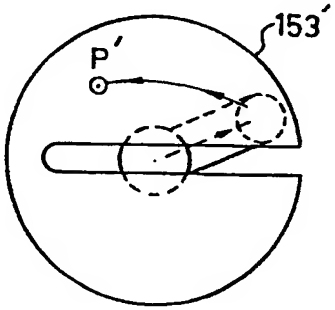
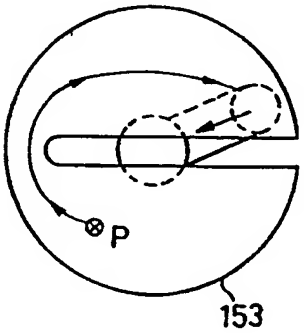
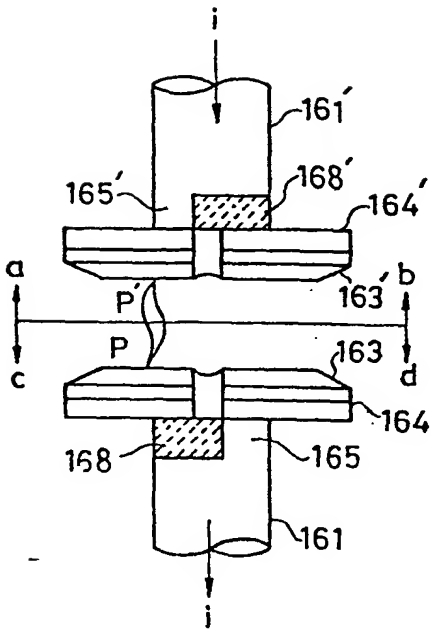


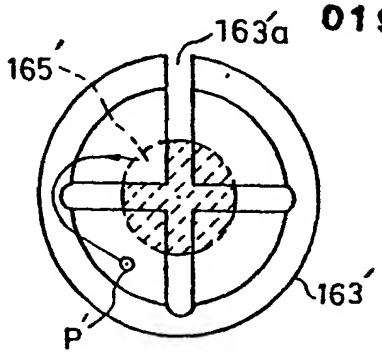
FIG.7(c)



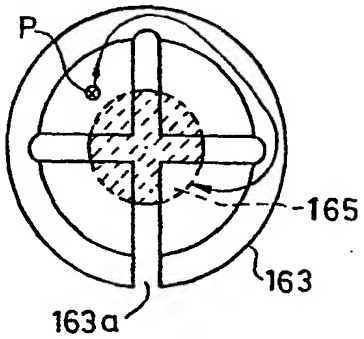
FIG,8 (a)



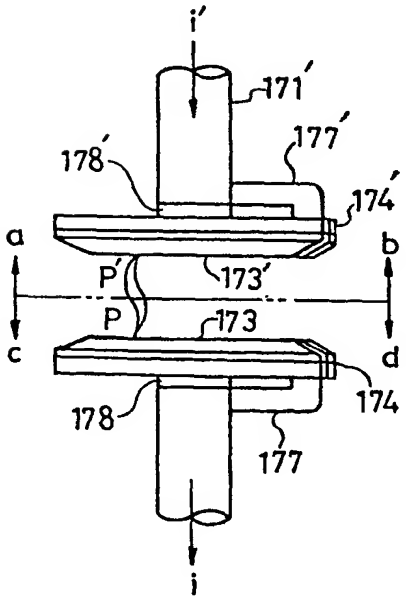
FIG,8,(b)



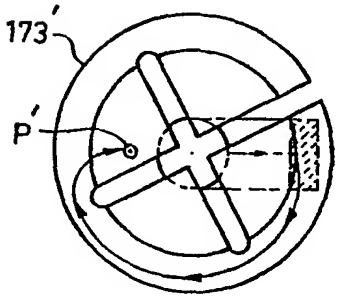
FIG,8 (c)



FIG,9 (a)



FIG,9 (b)



FIG,9 (c)

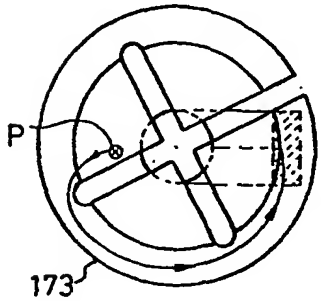


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FIG.10

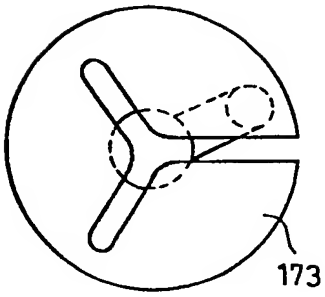

FIG.11

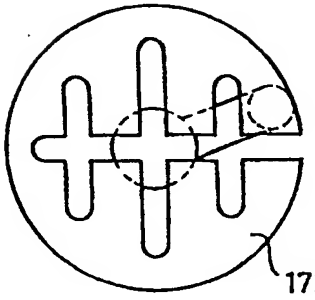

FIG.12

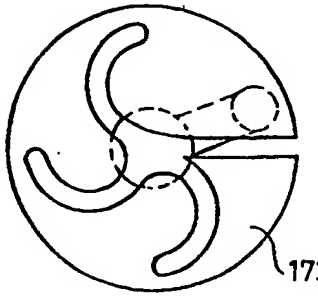

FIG.13(a)

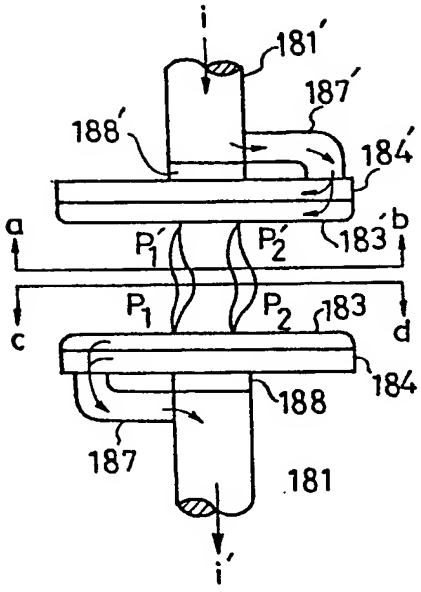

FIG.13(b)

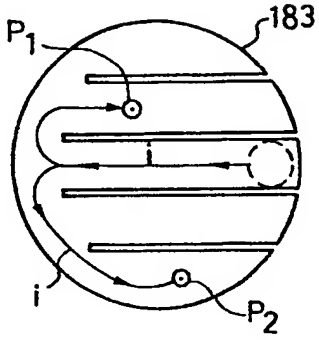

FIG.13(c)

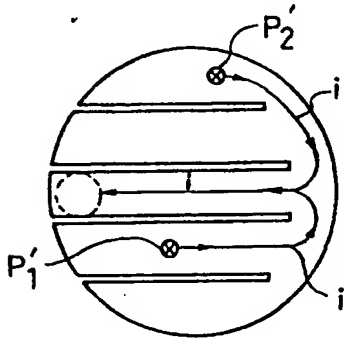

FIG.14(a)

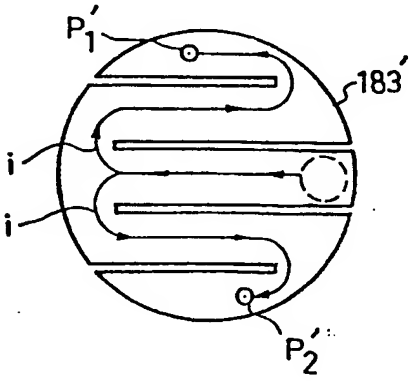

FIG.14(b)

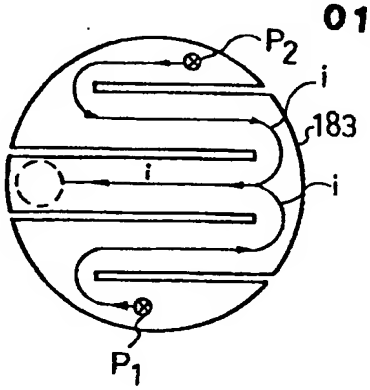

FIG.15(a)

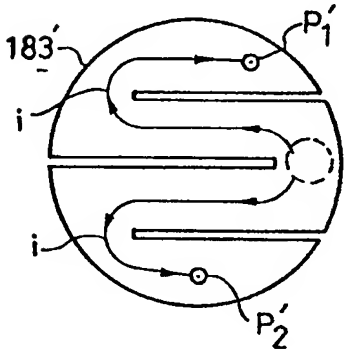

FIG.15(b)

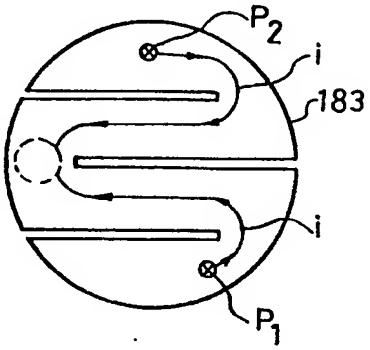

FIG.16(a)

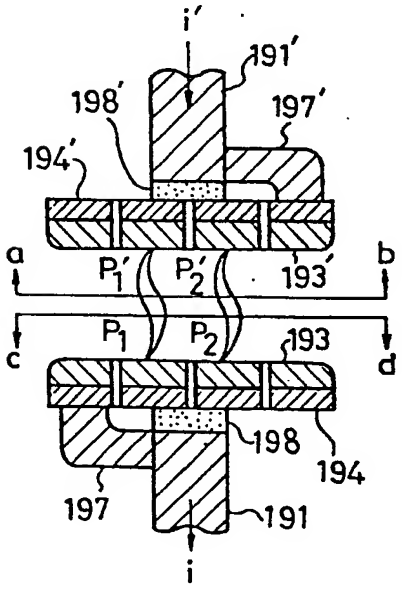

FIG.16(b)

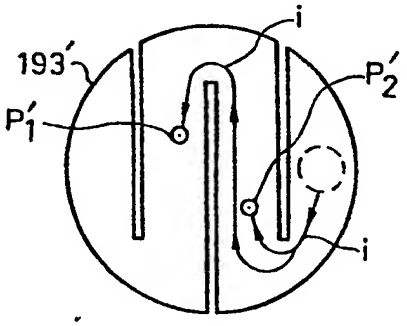

FIG.16(c)

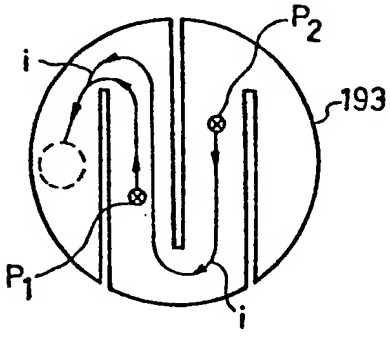

FIG.17(a)

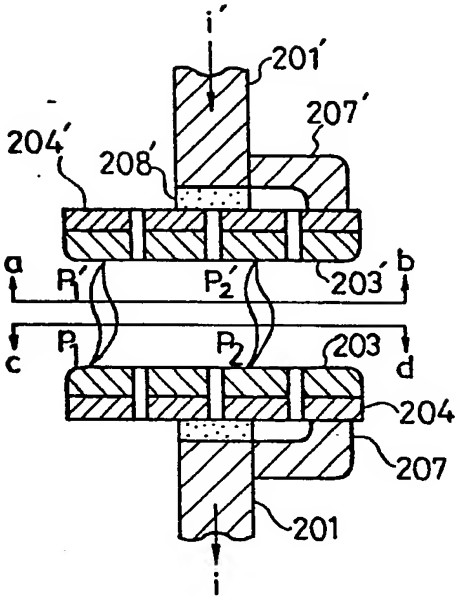

FIG.17(b)

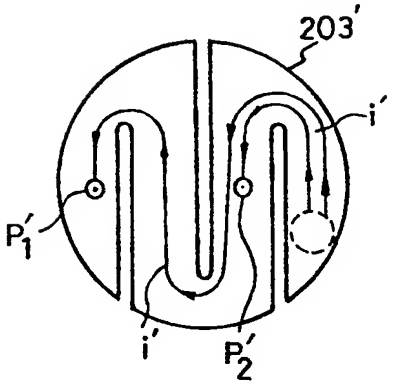

FIG.17(c)

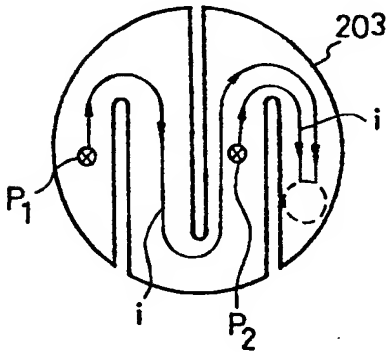

FIG.18(a)

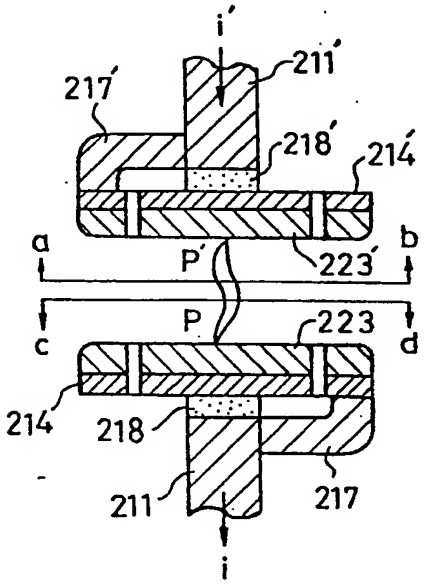

FIG.18(b)

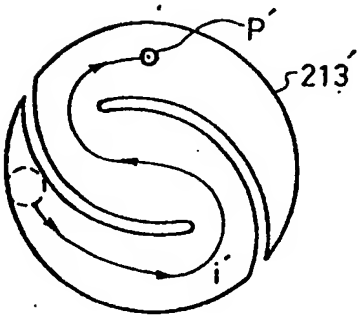

FIG.18(c)

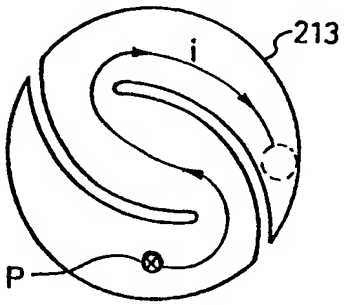

FIG.19(a)

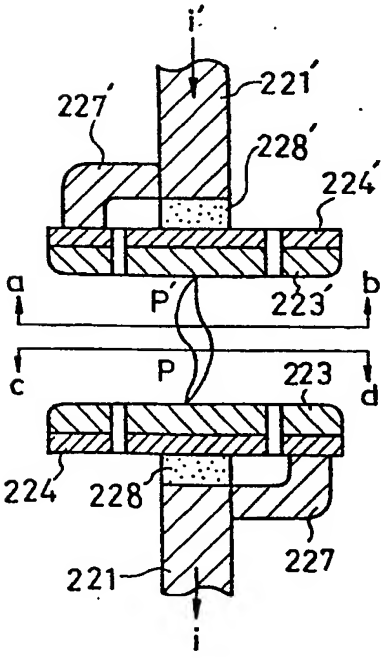

FIG.19(b)

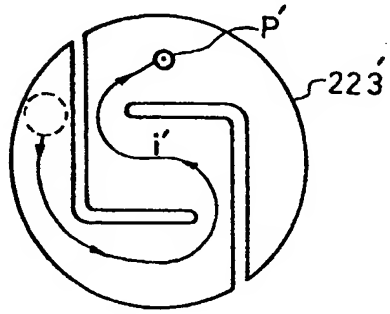

FIG.19(c)

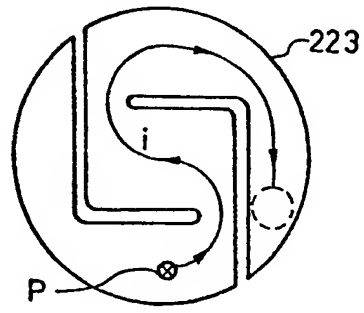

FIG.20(a)

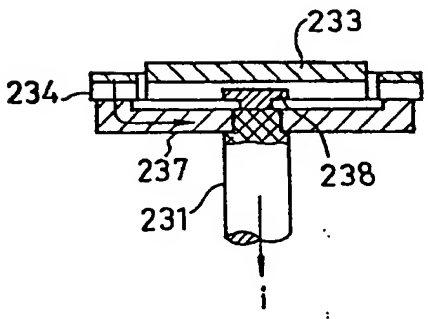

FIG.20(b)

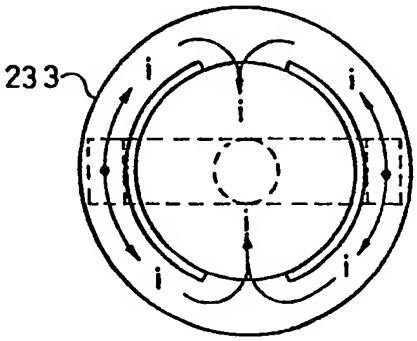

FIG.21

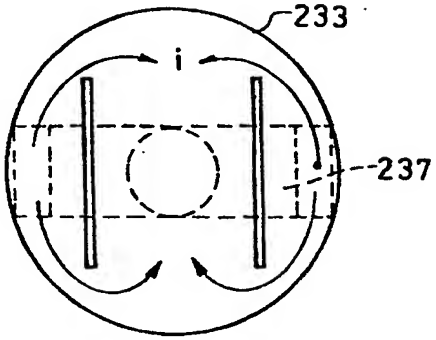

FIG.22

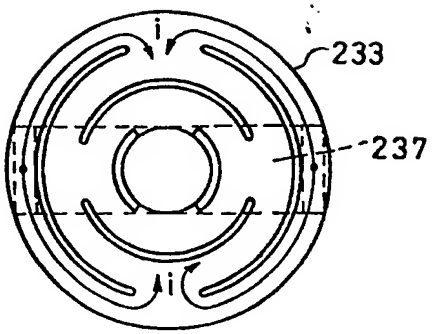

FIG.23